The California Regional Climate Model Intercomparison

Norm Miller[1,2], Jiming Jin[1], Nicole Schlegel[1,3]

Lisa Sloan[4], Mark Synder[4],Travis O'Brien[4], Laura Kueppers[5]

Masao Kanamitsu[6], Hideki Kanamaru[6], Kei Yoshimura[6]

Hugo Hildago[6], Mike Dettinger[6,7], Dan Cayan[6,7]

Phil Duffy[8,5], Karl Taylor[8,9]

[1]**Climate Science Department, Berkeley National Laboratory**
[2]**Geography Department, University of California, Berkeley**
[3] **Earth and Planetary Science Department, University of California, Berkeley**
[4]**Climate Impacts Laboratory, University of California, Santa Cruz**
[5] **School of Natural Resources, University of California, Merced**
[6]**Climate Research Division,Scripps, University of California, San Diego**
[7]**U.S. Geological Service**
[8]**Environment and Energy Directorate, Lawrence Livermore National Security**
[9]**Program for Climate Model Intercomparison and Diagnostics**

Fourth Annual
California Climate Change Conference
Science for Managing Climate Change in California:
Vulnerability, Mitigation, and Adaptation

September 10-13, 2007, Sacramento Convention Center

Outline

- **The Importance of Intercomparison Analysis**

- **Approach: Space-Time Quantification of Variables and Fluxes**
  - **Temperature**
  - **Precipitation**
  - **Snow Water Equivalent**
  - **Geopotential Height Fields and Precipitation**
  - **Taylor Diagrams**
    - **Minimum and Maximum Temperature**
    - **Precipitation and Snow Water Equivalent**

- **Summary**

- **Questions**

The Importance of Model Intercomparisons

- • Intercomparisons provide quantitative evaluations of model and process performance compared to observations and other models.

- Intercomparisons allow for model advancements, leading to reduced errors, and improved model predictability.

- Intercomparisons are essential for understanding how model simulated projections of the future compare with the present.

- Improved model predictability will allow for *better decision making* of actions needed for climate change mitigation, adaptation, and coping strategies.

Dynamic and Statistical Downscaling

• **Dynamic downscaling is a weather or climate (*average of weather*) simulation with complete meteorological equations resulting in weather variables and fluxes (Temperature, Precipitation, Relative Humidity, Wind, Radiation, Latent and Sensible Heat, Soil Moisture, Runoff, …).**

• **Dynamic downscaling requires a large amount of computational and data storage resources. It tikes a long time to complete the simulations.**

• **Statistical downscaling is based on coarse-resolution predictors that lead to high-resolution predictands for *temperature and precipitation.***

• **Statistical downscaling assumes stationarity of the projected climate system and cannot capture higher moments.**

• **Statistical downscaling is computationally inexpensive and many representations can be generated quickly.**

Approach

Modeling Groups: Three Dynamic and One Statistical

- **Berkeley Lab and UC-Berkeley:**

 NCAR **W**eather **R**esearch and **F**orecasting Model with

  (1) **R**apid **U**pdate **C**ycle (**WRF-RUC**)

  (2) **C**ommunity **L**and **M**odel version **3** (**WRF-CLM3**)

- **UC-Santa Cruz:**

 ICTP **R**egional **C**limate **M**odel version **3** (**RegCM3**)

- **UC-San Diego:**

  NOAA **R**egional **S**pectral **M**odel (**RSM**)

- **UC-San Diego:**

 Constructed **A**na**l**ogues Statistical Model (**CANA**)

Some of the Model Features

	Model Resolution Upper Limit	Vegetation	Soil	Snow	Lake	River-Routing
WRF-CLM3	1 meter	Up to 10 vegetation types in one grid, Sub-grid representation Dynamic vegetation	10-layer soil Frozen soil	5-layer snow Liquid water within snow Variable snow density	10-layer lake Snow and ice on the lake included	A simple digital elevation model (DEM) to calculate water flow directions
WRF-RUC	1 meter	One vegetation type in one grid cell NO Dynamic vegetation	6-layer soil Frozen soil	2-layer snow No liquid water within snow Fixed snow density	N/A	N/A
RegCM3-BATS	1 kilometer	One vegetation type in one grid cell NO Dynamic vegetation	3-layer soil No Frozen soil	1-layer snow No liquid water within snow Fixed snow density	Multi-layer lake model with snow and ice on the lake	N/A
RSM-Noah	1 kilometer	One vegetation type in one grid cell NO Dynamic vegetation	4-layer soil Frozen Soil	1-layer snow lumped with soil surface layer	N/A	N/A

Model Standards for Intercomparing

- **Each RCM used the same set of double nested domains and resolutions (A) Western U.S. at 30-km and (B) CA at 10-km.**

- **Each RCM used the same set of external forcing, the NCAR/NCEP Reanalysis II dataset for Initial and Lateral Boundary Conditions.**

- **Each RCM was required to generate a 10 year historical simulation, 1 January 1980 to 31 December 1989.**

- **Each RCM saved a common set of specified varies, fluxes, mapped these onto common grids for analysis.**

- **We follow the PCMDI protocols for IPCC AR4 Intercomparisons.**

Model Domains and Resolutions
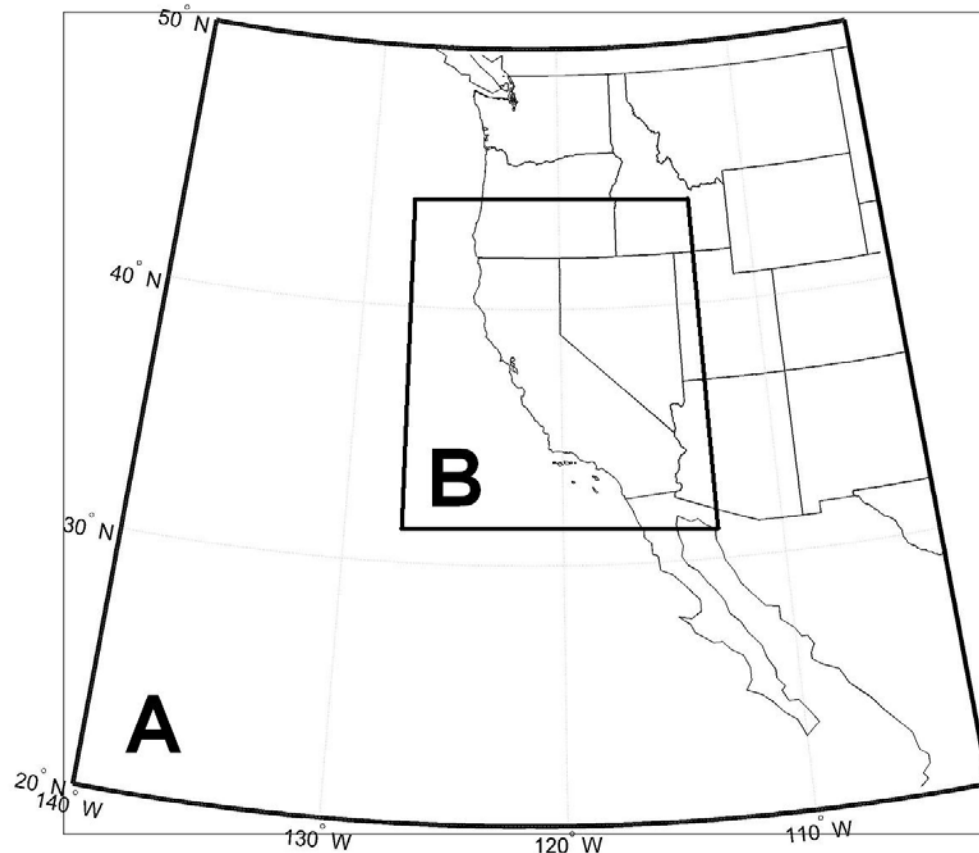
A - **Western U.S. and Eastern Pacific Ocean, 30-km resolution, [139W21N x 104W51N]**
B - **California, Nevada, Eastern Pacific Ocean, 10-km resolution, [128W31N x 113W44N]**

Maximum Temperature
June - August
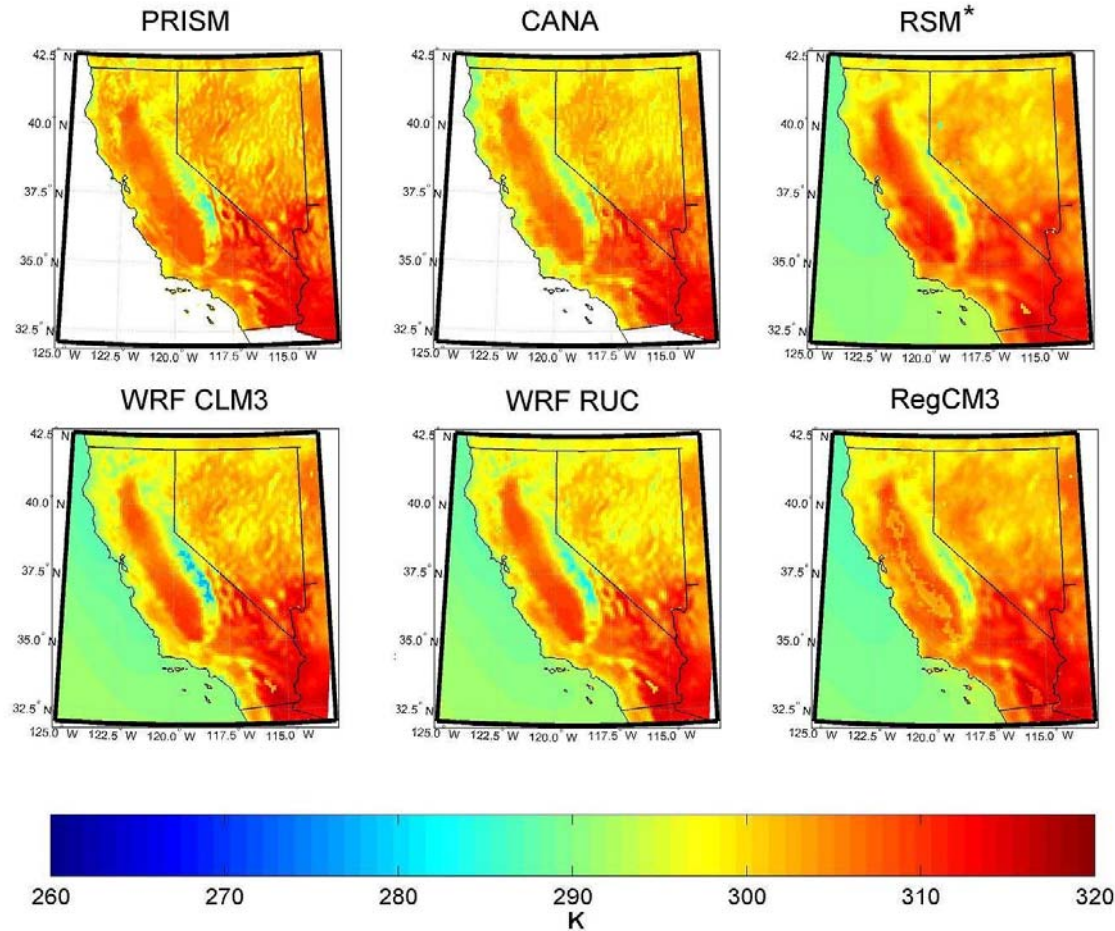
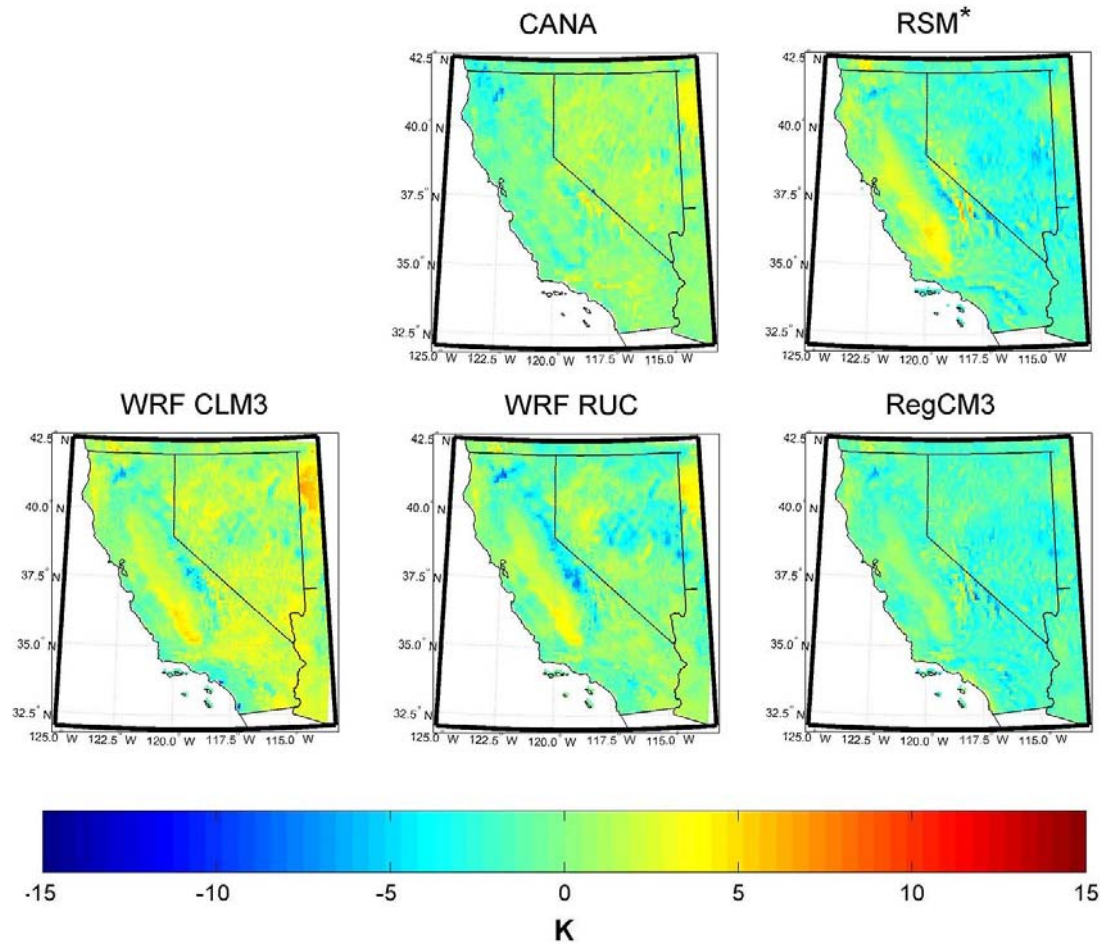# Maximum Temperature Difference
June - August
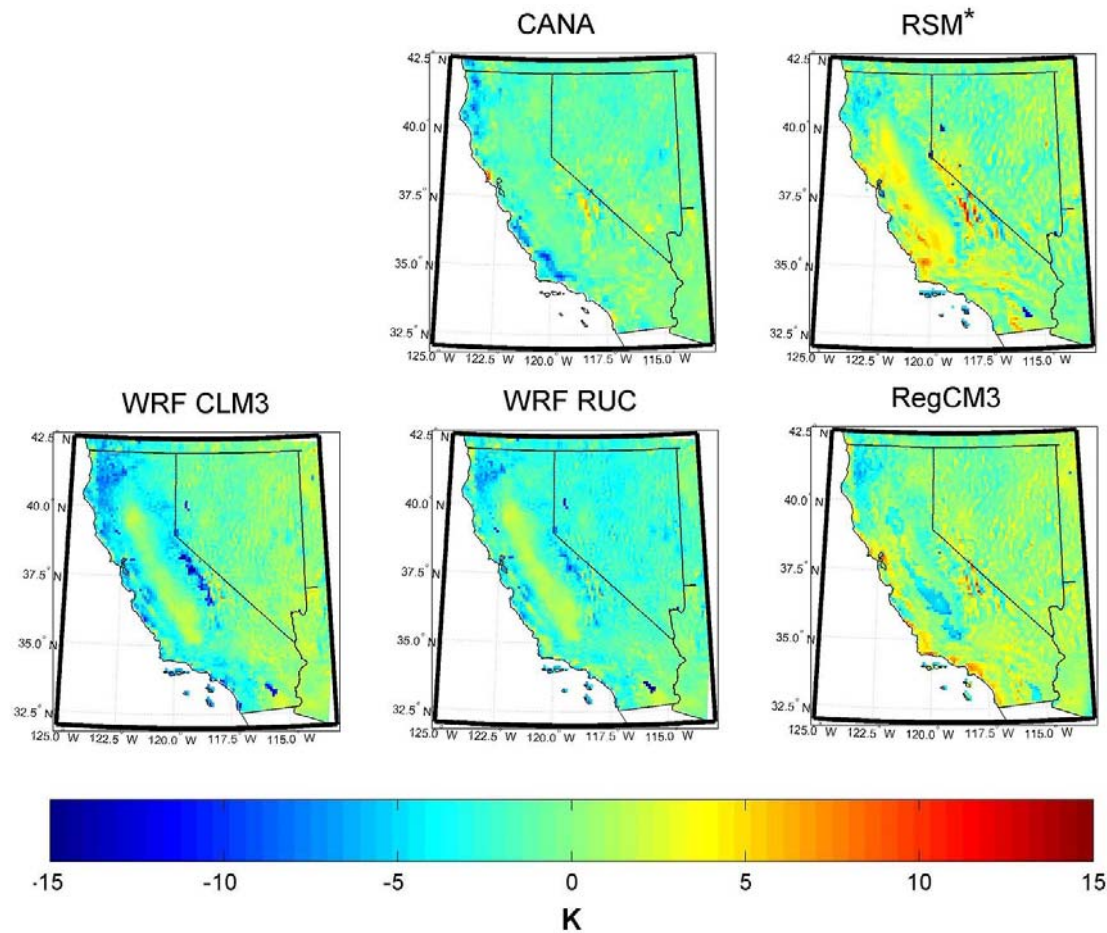
Minimum Temperature
June - August
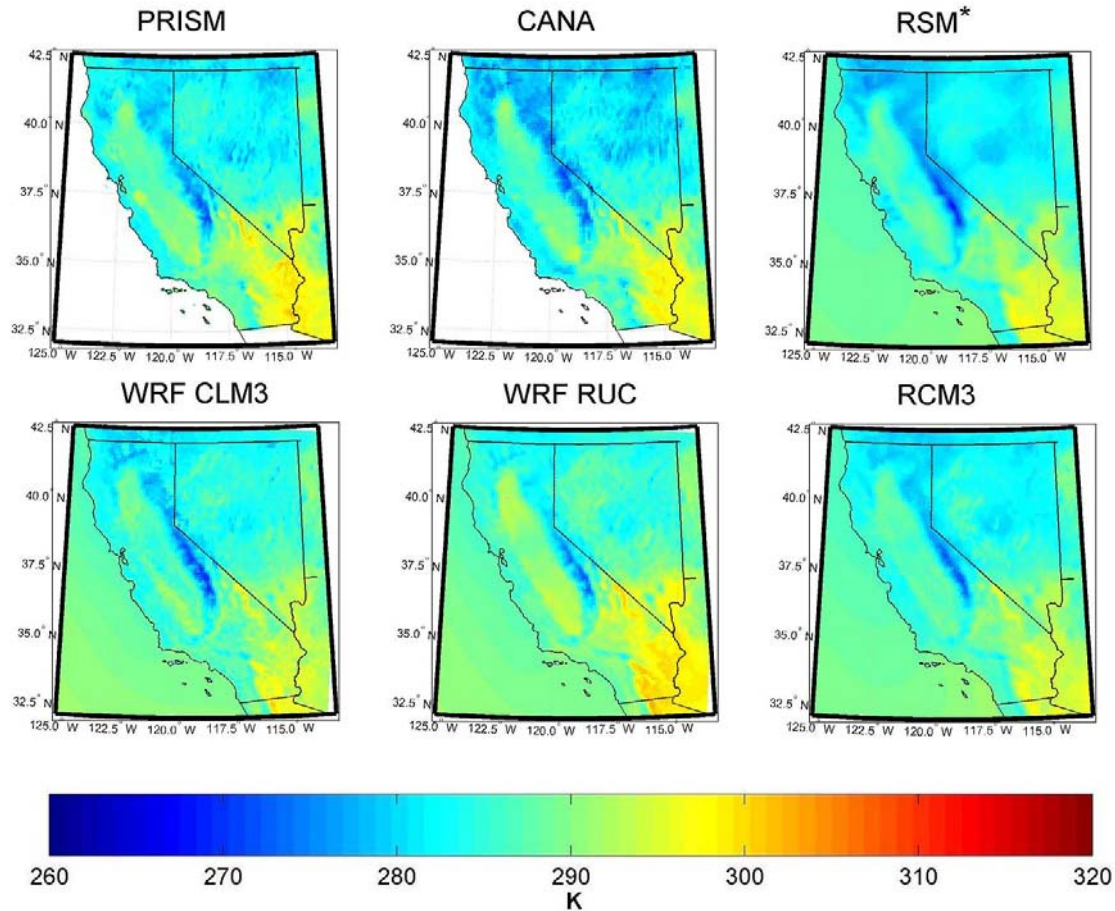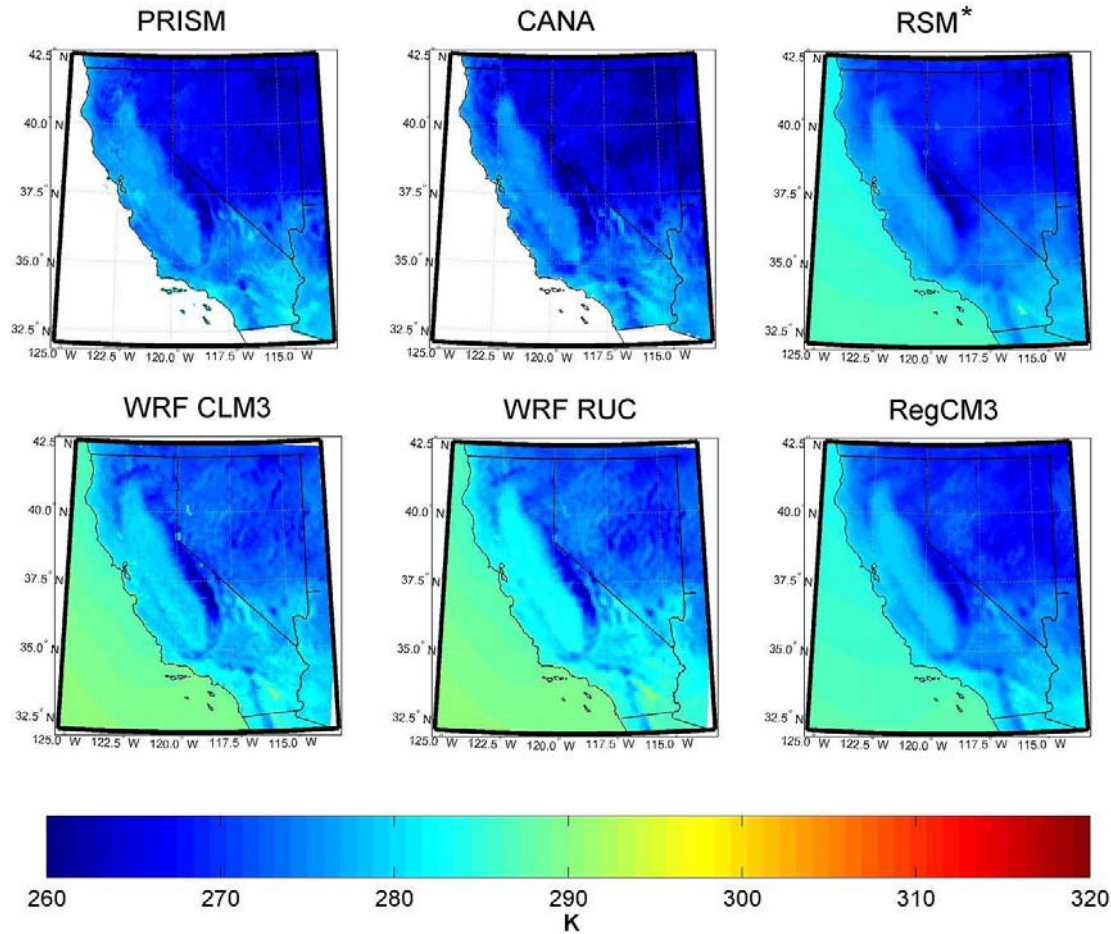
Minimum Temperature Difference
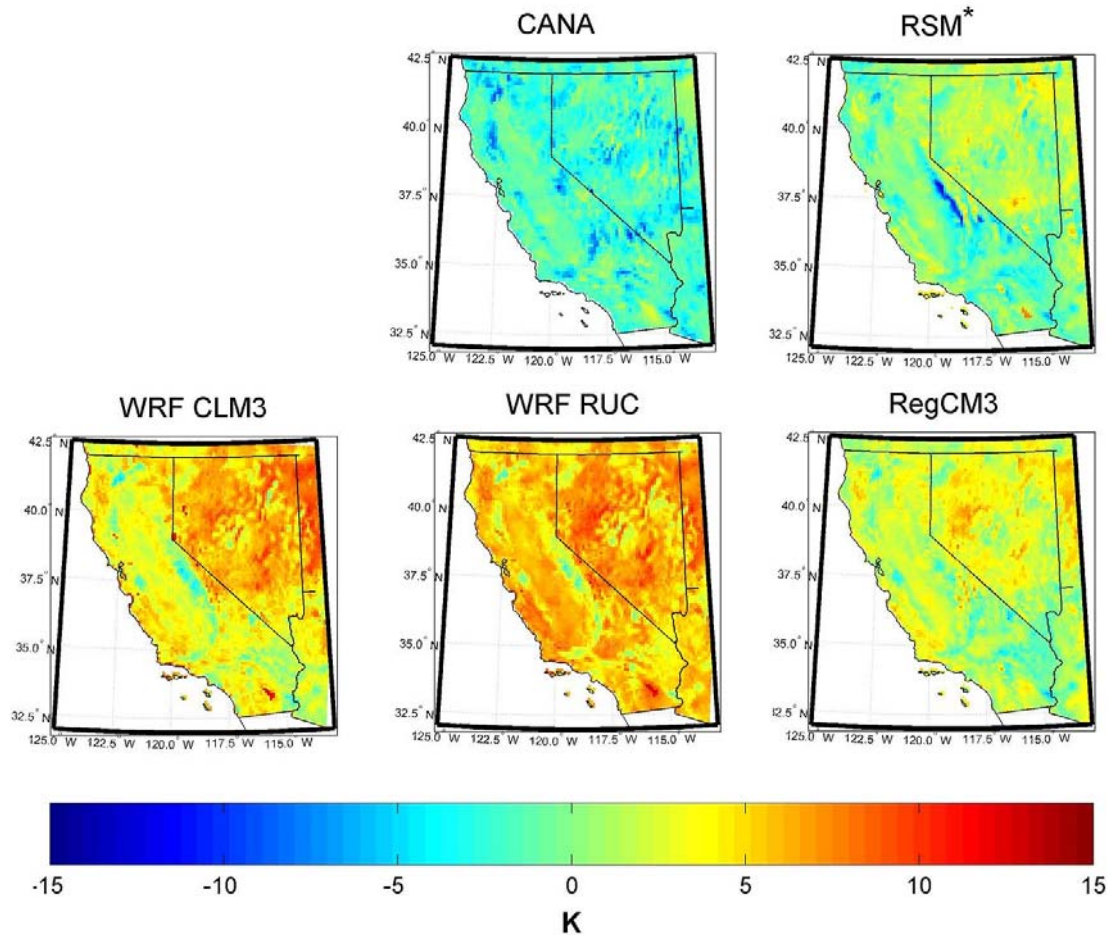## *June - August*
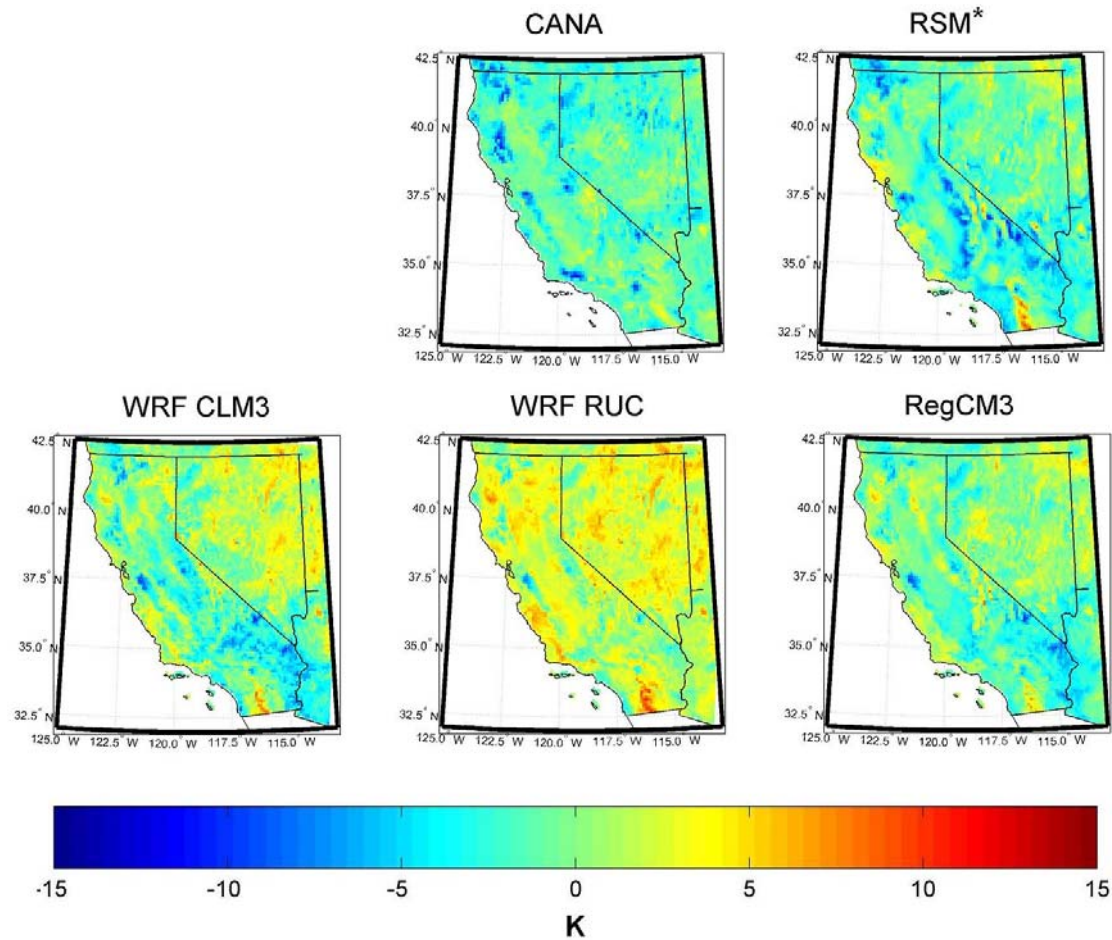
Maximum Temperature
December - February
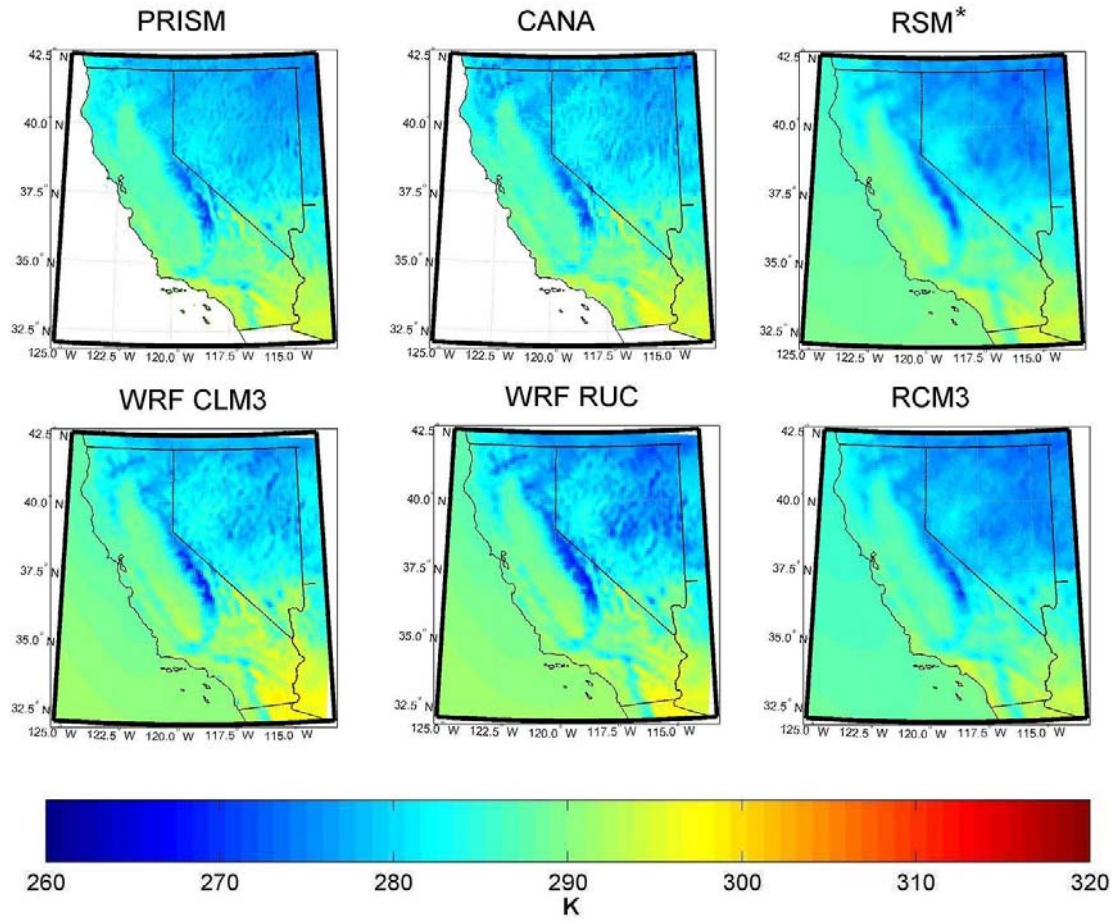
Maximum Temperature Difference
December - February

Minimum Temperature
December - February
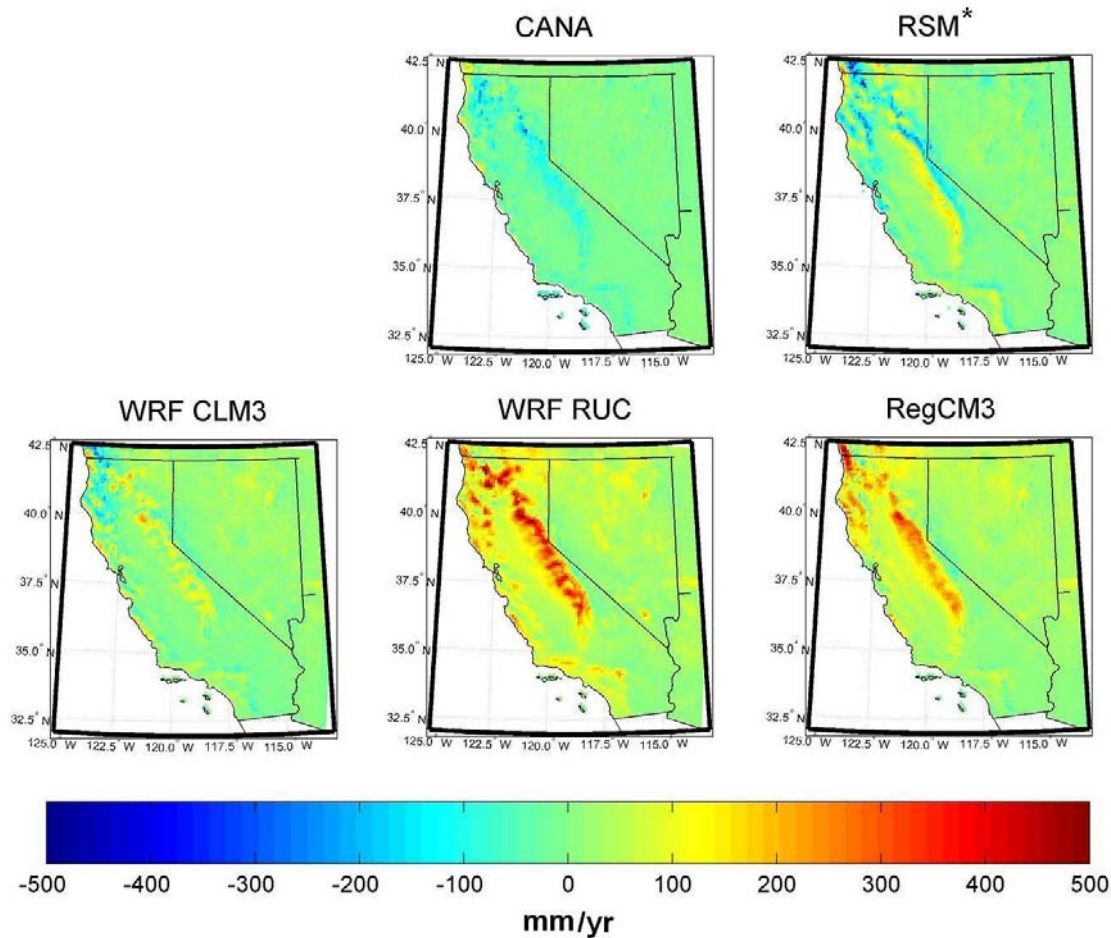
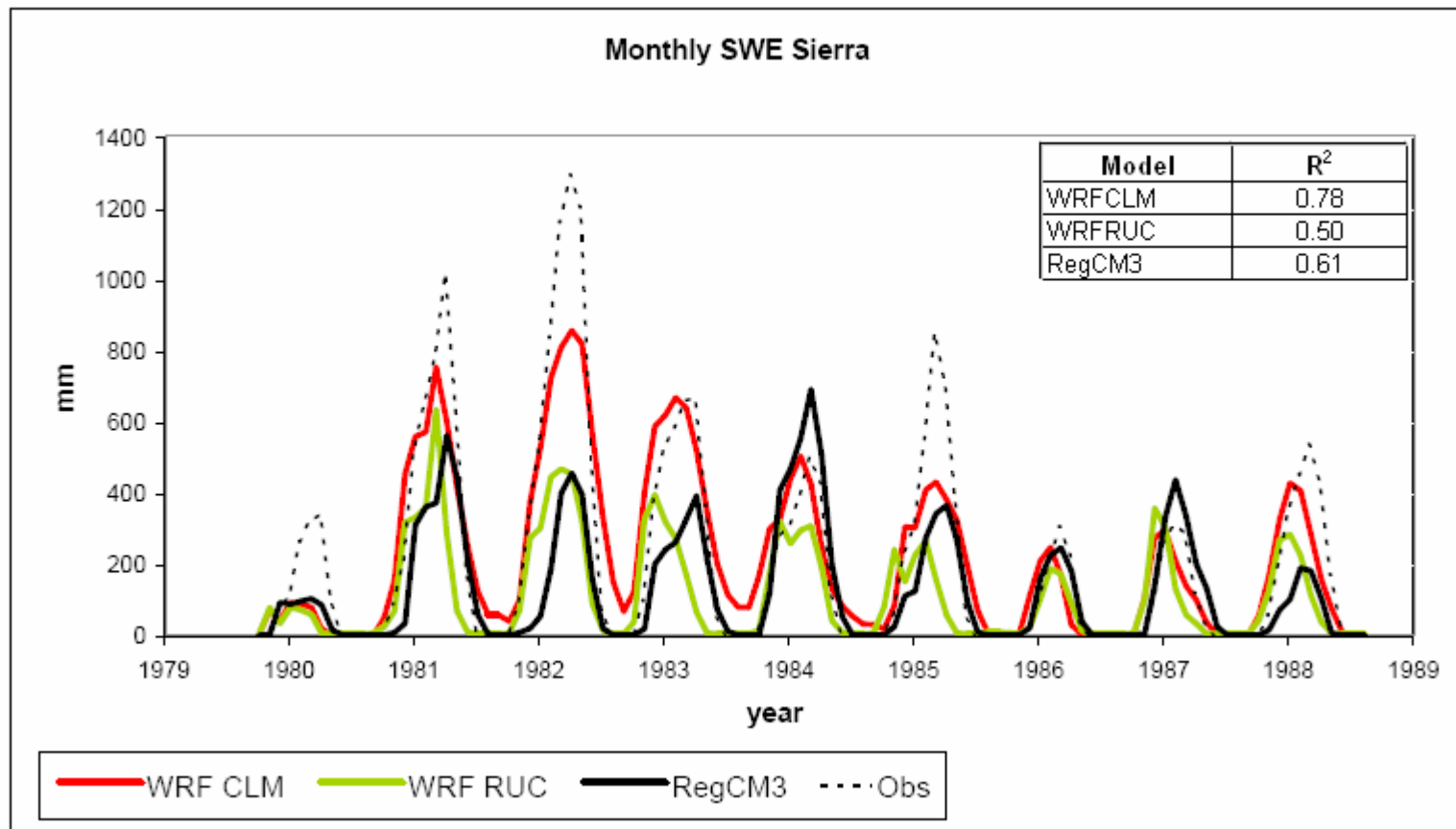# Minimum Temperature Difference
December - February

Precipitation
November - March
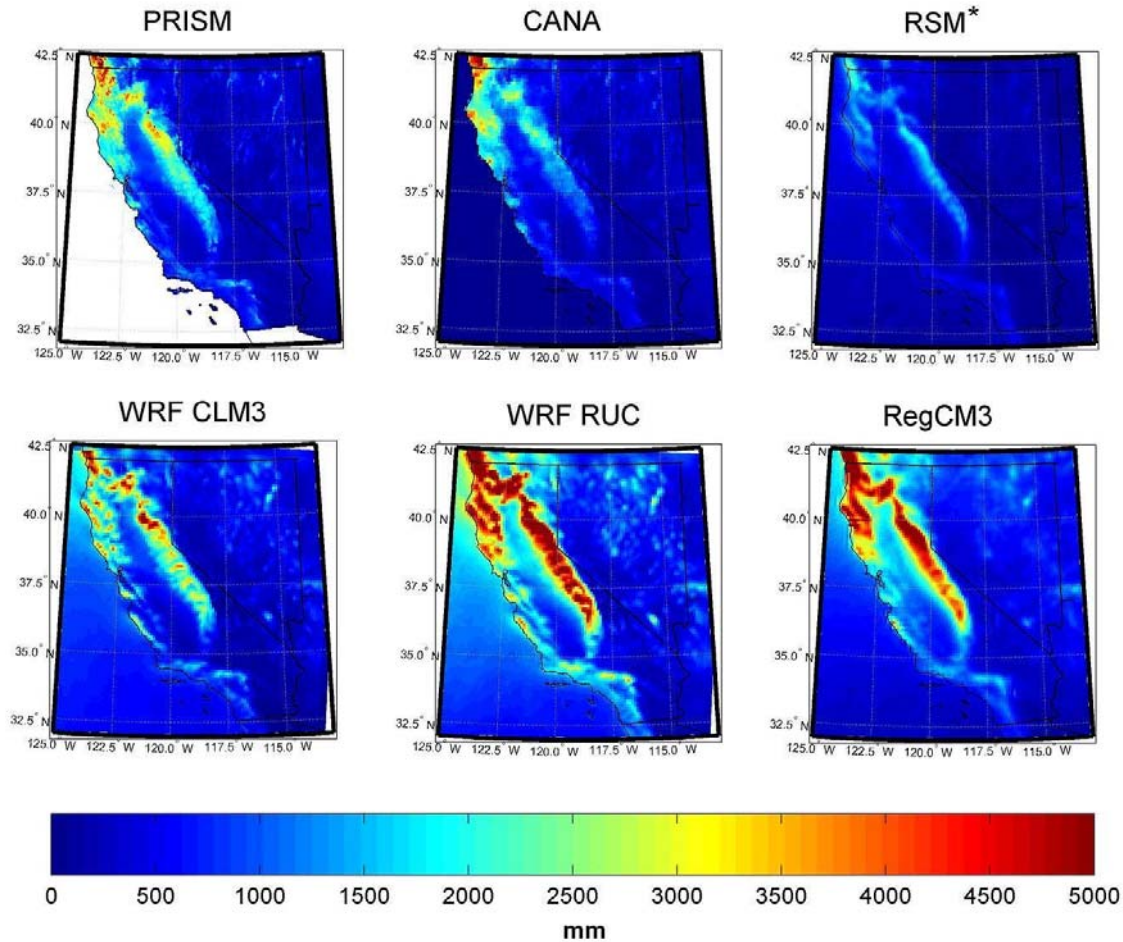
Precipitation Difference
November - March

Sierra Nevada Snow Water Equivalent
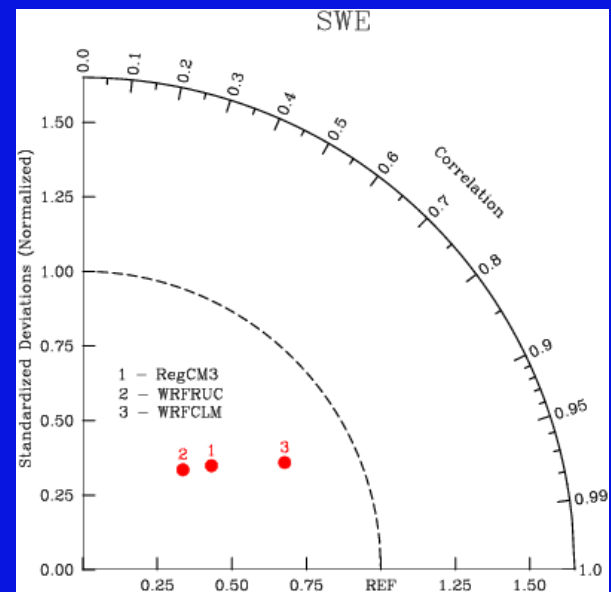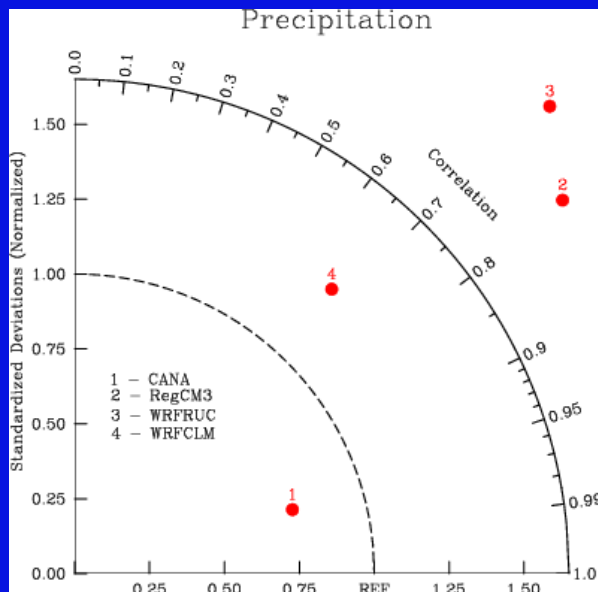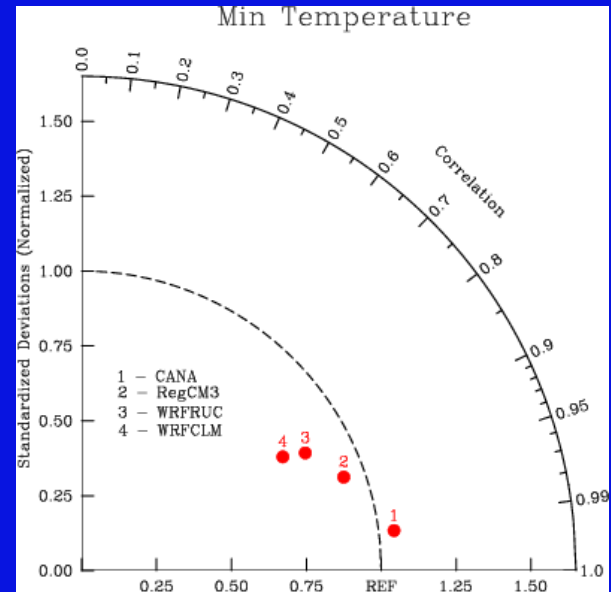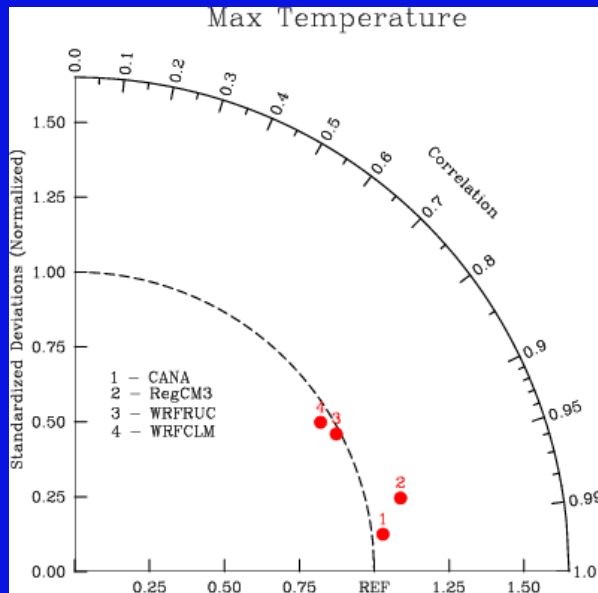
1982 November - March 1983 El Nino
WRF - CLM

Geopotential Height (hPa)

Daily Precipitation (mm/day)

QuickTime™ and a
decompressor
are needed to see this picture.

Model Performance Summary

Summary:

- **Complete RCM analysis of model performance and bias for 10 years, and some groups will extend to 25 years (1980 -2005). Quantify model bias for ensemble member weighting.**

- **Simulate the historical climate with the IPCC Global Climate Models as input forcing to the RCMs.**

- **Begin 10 - 25 year "time slice" simulations of early-, mid-, and late-century California climates at 30-km nested to 10-km resolution.**

- **Calculate projected climate sensitivities based on the differences between the model-simulated future and current climates.**

- **Send output data to the Climate Change Scenarios Assessments.**

Questions

QuickTime™ and a
BMP decompressor
are needed to see this picture.

NCAR Nested Regional Climate Model (WRF-RUC)